REMARKS

This Amendment is filed in connection with a Request for Continued Examination and a 2-month Extension of Time, and in response to both the Final Office Action mailed on January 27, 2005. All objections and rejections are respectfully traversed.

Claims 1-42, 45-58, and 60-70 are now pending.

Claims 2, 35, 36, 39, 40, 50, 51, and 55 have been amended to better claim the invention

Claims 60-70 have been added.

Claims 43, 44, and 59 have been cancelled without prejudice.

The Applicant has noticed that claims 43 and 44 were identical to claim 29. Accordingly, the Applicant has cancelled the extra identical claims without prejudice.

At paragraph 2 of the Office Action, claims 1-59 were restricted into two groups: claims 1-58 and claim 59. Further, the Examiner has withdrawn claim 59 from consideration as being directed to a non-elected invention. To advance the prosecution of this case, the Applicant has cancelled claim 59 without prejudice.

At paragraph 3 of the Office Action, claims 1-10, 17-19, 24-27, 30-42 and 45-58 were rejected under 35 U.S.C. §102(b) as being anticipated by U.S. Patent No. 6,158,017 issued on December 5, 2000 to Han et al. (hereinafter "Han").

The present invention, as set forth in representative claim 1 comprises in part:

1. A system adapted to correct multiple storage device failures in a storage array using a combination of multiple first parity groups and a single secondary parity group, the system comprising:

a storage array having a plurality of concatenated sub-arrays, each sub-array including a set of data storage devices and a first parity storage device, the array further including ***a global secondary storage device associated with the storage array and holding secondary parity values for the single secondary parity group, the secondary parity values computed across the concatenation of the sub-arrays***.

Han discloses two different parity arrangements, DH and DH2. Both parity arrangements utilize a single disk array having diagonal parity (D) striped across multiple storage disks in the array. *See* col. 3, lines 8-9 and col. 3, lines 31-32. For example, figs. 6 and 9 respectively illustrate the DH and DH2 implementations having diagonal parity D striped across a row of storage disks d0-d6. Horizontal parity (H) in the DH arrangement is also striped across multiple disks (*see* Fig. 5), whereas horizontal parity is stored in a single disk in the DH2 arrangement (*see* Fig. 8).

The Applicant respectfully urges that Han is silent concerning the Applicant's claimed invention relating to "***a storage array having a plurality of concatenated sub-arrays, each sub-array including a set of data storage devices and a first parity storage device***" and "***a global secondary storage device associated with the storage array and holding secondary parity values for the single secondary parity group, the secondary parity values computed across the concatenation of the sub-arrays.***"

The Applicant's claimed invention includes a ***plurality of concatenated sub arrays*** where each sub-array includes ***a set of data storage devices and a first parity device.***

In contrast, Han only discloses parity arrangements with a ***single*** array of storage devices. As the Applicant discusses in greater detail below, since Han teaches a single array of storage devices, Han necessarily is silent concerning all aspects of the Applicant's claimed invention that require multiple sub-arrays.

In order to better understand the Applicant's claims, the Applicant respectfully directs the Examiner's attention to the illustrative embodiment shown in Fig 3. of the Application. Description of this embodiment may also be found at page 12, lines 16-21, which state:

> Fig. 3 is a schematic block diagram of storage array 300 organized as a plurality of concatenated sub-arrays 310, wherein each sub-array includes a set of data disks (D_1, D_2) and a parity disk (P_{R1}, P_{R2}). Illustratively, each sub-array 310 is arranged as a concentrated parity, e.g., a RAID-4 style, disk array [A0, A2 ... An] comprising a predetermined number (e.g., seven) of data disks 320 and a row parity disk 330. The cardinality of each sub-array is denoted by Ck (k=0 ... n).

Turning to Han, the Applicant respectfully directs the Examiner's attention to Fig. 3 and Fig. 4 of Han, and specifically to the single array of disks (storage devices) labeled d0, d1, d2, d3, etc. While the disks are shown to have blocks b0, b1, b2, b3, etc., these blocks are merely portions of each disk (storage device).

In the Office Action of January 27th, 2005 the Examiner suggests one of Applicant's ***concatenated sub-arrays*** is analogous to one of Han's disks (storage devices). *See* Office Action paragraph 3. Such an analogy is improper. The Applicant claims ***concatenated sub-arrays*** each ***including a set of data storage devices and a first parity de-***

vices. A concatenated sub-array as defined must include multiple storage devices, such as disks.

Please note, while an illustrative embodiment in the Application shows storage devices to be disks, the Applicant has expressly contemplated storage devices can be other devices, such as tapes or dvds. *See* page 10, line 26 to page 11, line 4. Yet regardless of which storage medium a storage devices embodies, multiple storage devices may not be a single disk. Accordingly, Han's single disk (storage device) may not be reasonably interpreted to be a concatenated sub-array.

Flowing from Han's lack of disclosure of concatenated sub-arrays, Han is necessarily silent concerning Applicant's ***secondary parity values computed across the concatenation of the sub-arrays*** and storing such values in a ***global secondary storage device associated with the storage array.*** Instead, Han simply discloses calculating diagonal parity across a single array.

The Applicant recognizes the inefficiency of Han's approach in the Background section of the Specification, commenting on computing secondary parity across the same size array as primary parity (as Han teaches). At page 4, lines 12-16 of the Application, the Applicant states:

> The reconstruction process time also increases as the size and number of disks in the storage system increases, as all of the surviving disks must be read to reconstruct the lost data. Moreover, the double disk failure rate is proportional to the square of the number of disks in a parity group. However, having small parity groups is expensive, as each parity group requires an entire disk devoted to redundant data

And at page 4, lines 12-16 of the Application the Applicant further explains:

> In addition, the amount of work the system must do to recover from a failure (and thus the recovery time if the system is constrained) is also proportional to the disk array size. A system with 2n disks takes twice as long to recover as a system with n disks. Together these factors limit the practical size of a RAID group even with protection with multiple disk failures.

Thus a system built according to Han would likely be expensive or suffer from poor recovery time. The Applicant's claimed novel invention solves this tradeoff by computing some parity across sub arrays and other parity across the entire array.

Accordingly, the Applicant respectfully urge that Han is legally insufficient to anticipate the presently claimed invention under 35 U.S.C. § 102(b) because of the absence of the Applicants' claimed novel "***a storage array having a plurality of concatenated sub-arrays, each sub-array including a set of data storage devices and a first parity storage device***" and "***a global secondary storage device associated with the storage array and holding secondary parity values for the single secondary parity group, the secondary parity values computed across the concatenation of the sub-arrays.***"

In the event that the Examiner deems personal contact desirable in disposition of this case, the Examiner is encouraged to call the undersigned attorney at (617) 951-3078.

All independent claims are believed to be in condition for allowance.

All dependent claims are believed to be dependent from allowable independent claims.

The Applicant respectfully solicits favorable action.

Please charge any additional fee occasioned by this paper to our Deposit Account No. 03-1237.

Respectfully submitted,

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